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Handwritten Notes for Minsky's PhD Thesis titled Statistical Material

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Statistical Material:

It is with heavy ~~uneasy~~ hand and uneasy heart that a cursory examination of the record is attempted in order to see if the concepts sketched in the theory have any reference to analysis of available data. In order to limit the ~~statistical analysis to~~ data ~~Capitalto~~ to be analyzed I confined myself to material data in Kuznets "National Product Since 1869" — primarily the material in ~~the~~ Part II, Decade Estimates 1869-1939. and some from Part IV- Reproducible Wealth, its Growth and Industrial Distribution 1880-1939.

~~The meaning of the beginning~~

Analysis of statistical data in reference to theory should not be cursory: however due to time and resources available this examination will have to be of that unsatisfactory nature.

In discussing the relationship between income and investment we, following Domar, practically speaking defined σ as $\frac{\Delta Y}{I}$, under the assumption of continuous full employment. In analysing the statistical record we would want to ~~differentiate~~ define investment as ~~this~~ σ as $\Delta Y/I$ as it appears in the record: e.g. the historical minutes in which dropping of the full employment ~~data~~ average capital coefficient ~~does~~ lets call it $\bar{\sigma}$ which is ~~in addition~~ as defined as $\frac{Y}{K}$., Income decided by Capital; Income produced per unit of capital: $\bar{\sigma}$ also is historical given the conditions of employment.

Now Abstractly $\sigma \gtrless \bar{\sigma}$, if $\sigma < \bar{\sigma}$ then the marginal income productivity of capital is less than the average - capital is being deepened: if $\sigma = \bar{\sigma}$ the condition is one of essential homogeneity of new powers with old, capital being widened; and if $\sigma > \bar{\sigma}$ the efficiency of investment is being increased. When $\sigma > \bar{\sigma}$ the essential element of the investment is its labor saving nature.

Tables 1, 1a, 2 and 3 summarize material from Kuznets's National Product Since 1869". The value of "Real Estate Improvements and Equipment" at census years is used in table 1 as the estimate of Capital - in table 1a the total inventories is added to give an estimate of "Reproducible Wealth". The use of "Real Estate Improvements and Equipment" in the rest of the 'analysis' is arbitrary: the only rationale being that the fixed equipment may be a better first approximation to capital than the inventories: the fact that the difference at ~~most~~ seems to have a fairly constant % declining from 33% in 1869 to 20% in 1929, and remaining at about 20% since then. The only difference is in the magnitudes of $\bar{\sigma}$, σ: and it is really their changes, and their relation is, which are important

Table I

Capital and Income.
1879-1939
in 1929 Prices

year	1. Value of Capital at 1st of year. Billions	2. Net National Product. 10 yr. averages: ebbed in census years:	3. $\overline{\sigma}$ = Ratio of Income to Capital
1879	30 ✓	14 ✓	.47 ✓
89	51 ✓	21 ✓	.40 ✓
99	87 ✓	30 ✓	.344
09	132 ✓	45 ✓	.341
19	177 ✓	57 ✓	.322
29	228 ✓	73 ✓	.320
39	236 ✓	88*	.37

Column 1. Kuznets: National Product since 1869: Table IV-11 p 230. Value of Real Estate and Improvements + Equipment Selected Dates 1880-1939: 1929 Prices: Based on Capital Formation Data.

Column 2. Kuznets: National Product since 1869 Table IV-16 p 119. Gross and Net National Product by year and by Decades 1869-1938

Column 3. Ratio of column 2 to column 1.

* Table I-19: Net National Product, Peacetime and Wartime Studies Concepts: 1929 Prices 1919-1943 (billions of dollars). Arithmetic average of 10 years 1934 1943 in column 3: Net National Product. Dementia consistent with the 29 data.

Table I a

Capital and Income 1879 and 1939: in 1929 prices

Variant 2 using Growth of Reproducible Wealth other than household

Yr. Decade	1 Total Reproducible Wealth* Capital: billions	2 Net National Product: 10 yr average centered on census yr.	3 $\frac{2}{1}$
1879	40	14	.35
89	67	21	.31
99	107	30	.28
1909	158	45	.28
19	213	57	.27
29	270	73	.27
39	283	88	.31

* Foreign claims excluded.

Column 1. Ulmer's: Nat'l Prod. since 1869 Table IV -10 p228 Growth of Reproducible Wealth other than Household Selected Data 1880-1939: 1929 Price (millions of dollars) Used sum of Real Estate improvements and equipment, and Inventories Col(3). Ignored foreign claims.

Table II

Increments of Capital and Income
1879 – 1939
29 Prices

Table II

Decade	1. Increase in Value of Capital. Billions	2. Increase in Net National Product	3 increase in Ratio of Income to Increase in Value of Capital. $\frac{\Delta}{\sigma}$
1879-89	21	7	.33
89-99	36	9	.25
99-1909	45	15	.33
1909-19	45	12	.27
19-29	51	16	.32
29-39	8	15	1.88

Column 1. 1st differences of column 1 table 1.
2. 1st differences of colum 2 table 1
3 ~~Colum 1 div~~ Ratio of Column 2 to Column 1.

Table III

Comparison of Ratios of income to capital with ratios of increment of income to increment of capital.

	Ratio: Income to Capital $\frac{\text{Income}}{\sigma}$	Ratio: $\frac{\Delta \text{ income}}{\Delta \text{ capital}}$ $\frac{\Delta}{\sigma}$
79	47	
1889	40	33
99	35	25
1909	34	33
19	32	27
29	32	32
39	37	1.88

	Ratio Income to Capital $\frac{\text{Income}}{\sigma}$	Ratio: Increase income to increase in capital $\frac{\Delta}{\sigma}$
1879	47	33
89	40	24
99	35	33
1909	34	27
19	32	32
29	32	1.88
39	37	

The estimates of $\bar{\sigma}$ in both tables 1, excluding inventories, and Table 1a, including inventories, has been similar. The comparison of the ratio of Net Material Product, 10 yr average centered around the years for which estimate of Capital are available with capital during the period covered (Column 3 in table 1, 1a) shows that until 1929 $\bar{\sigma}$, the ratio of income to capital, was a monotonically decreasing one: although for some of the period between 1899 and 1909 and 1919, 1929 the decrease was so slight as to be considered as insignificant.

The decreasing average rate means that at least in some periods, the rates of increase in income to investment must have been considerably less than the average income-capital ratio. Table 2 column 3, has the values of $\bar{\sigma}$: The during the periods 1879-1899 the value of σ was less significantly lower than $\bar{\sigma}$, (Table 3, Column 1, 2) and again in 1909-19. During the period 1859-1909 and 1919-29 $\bar{\sigma}$ ± $\bar{\sigma}$ was approximately equal to $\bar{\bar{\sigma}}$.

During This periods of large 50 years, the statistical record showed both types of capital phenomena: 3 of the decades were decades of capital deepening $\sigma < \bar{\sigma}$, two were of widening $\sigma > \bar{\sigma}$.

Over the entire period there was a net investment resulted in an increase of capital in relation to income. Investment was proceeding at such a rate that the income/capital ratio was decreasing in spite of technological change - economic growth in terms of our terminology was proceeding at a greater rate than the natural rate of growth. When you add the element of population growth, of the increase in the labor force, the deepening of capital becomes even more marked.

In the period centering around 1939, Capital increased by only 8 billions, Net national product increased by 15 billions & the increment of income to the investment was 1.88, roughly 6 times the 1929 average ~~0~~. Capital formation during ~~1930~~ the great depression was a marvelous phenomena - or to put it in more usual language: a period of technological change without significant net investment.

As a result of the great depression, the ratio of income to capital increased to .37 for the period clustering around 1939: a value larger than any since 1899. If we add to this the declining rate of population growth, the which should have made for a deepening of the investment/output relation, the ~~growth of~~ magnitude of the great depression becomes

if anything more marked

An estimate of the effect of technological change during the 1929-39 period can be made. Net investment was 8 billion - income investment ratio in 1929 was 3.2 : therefore at the same ratio the increase in income would have been 2.5 billion. Leaving 12.5 Billion to be accounted for by technological change

Using 4% per annum depreciation reinvestment ratio some 98 billion would have been reinvested during the decade. This would at the 1929 productivity of investment yield 28.8 billions. The 98 billions reinvestment plus net investment, yielded this 28.8 plus 15 or 43.8 billions. A σ of .45; just short of a 50% increase in the productivity of investment during the decade; is the result. The labor saving nature of the 30's technology is evident - however the missing phenomena was the investment to pull σ down to the level of σ̄ : that was the 'stagnation' of the 30's.

Analysis of Table 4 and 5 dealing with the growth of Capital, Income and Labor force, shows that the rate of increase of capital has been decreasing constantly since 1879, the rate of increase of income fall into two periods: up till 1909 when income increased

Table 4. Growth of Capital, Income and Labor force: 1879-1939.

Growth of Capital.

	Value of Capital (Billions)	Increase in capital (1st differences) (Billions)	rate of change of increase in investment (2nd Differences)	Ratio: $\Delta K/K$. 10 yr. av.	rate of increase compounded annually %
1879	30				
89	51	21	—	.70	5.5
99	87	36	15	.71	5.5
1909	132	45	9	.52	4+
19	177	45	0	.34	3.0
29	228	51	6	.29	2.5
39	236	8	-43	.035	0.25

Growth of Net National Product.

10 year averages: centered on year indicated

	Net. Nat Product.	Increase in Net Nat Prod. (1st Differences) (Billions)	rate of change of increase in net nat product (2nd Differences)	Ratio $\Delta Y/Y$ 10 yrs	rate of increase compounded annually. %
1879	14	—	—		
89	21	7	—	50	4+
99	30	9	2	.43	3.5
1909	45	15	6	.50	4.+
19	57	12	-3	.27	2.5
29	73	16	4	.28	2.5
39	88	15	-1	.21	2.0

Growth of Labor force: Gainfully occupied

	Gainfully occupied	increase in gainfully occupied. 1st. Diff. (millions)	rate of change of increase in gainfully occupied 2nd Diff.	ratio $\Delta L/L$.	rate of increase compounded annually %
1879	16,740	—	—	—	
89	22,729	5,989	—	.36	3.0
99	28,311	5,582	- 407	.25	2.25
1909	35,954	7,643	2,061	.24	2.25
19	41,927	6,973	- 1,670	.17	1.5
29	47,953	6,026	153	.14	1.25
39	54.1	6.200	174	.125	1.13.

Table 5. Rate of increase of Capital, Income and Labor force.

rate of increase compounded annually

decade ending	Capital	Income	Gainfully Occupied.
1889	5.5	4+	3.0
99	5.5	3.5	2.25
1909	4.+	4+	2.25
19	3.0	2.50	1.5
29	2.5	2.5	1.25
39	0,25	2.0	1.13

from 3.5 to 4 % per year, and after 1914 when the rates of increase fell to 2.5% and to 2.0% during the great depression. The rate of increase of gainfully employed has been decreasing steadily from 3% in 1889 to 1.13% in 1939. In each decade up until 1939, the rate of increase of capital was greater than that of income (although fractional in 1909 and 1929) and labor was considerably smaller.

Capital grew at a greater rate than income: $\frac{\Delta I}{I} > \frac{\Delta Y}{Y}$ for each period.

The investment process again was a deepening. The growth of the labor force was significantly less than that growth of income so that the ratio of capital/worker was increasing.

Although we are out beyond the accuracy of both the data and the theoretical analysis, an attempt to estimate the growth of the effective labor force from the formula.

$$g = \frac{g_L + \mu(1-\lambda') + r}{\lambda}$$ follows.

Inasmuch as we will compare it with historic growth, the r factor can be eliminated.

$$g = \frac{g_L + \mu(1-\lambda')}{\lambda}$$

λ is the reciprocal of man hour output.

Using 1923-39 Data growth in man hour output in various segments are input computed from Bean 'A Record of Salient Economic Changes 1923-39'

Industry	1923	1939	Fraction	Approx annual rate %
Agriculture	87	124	142.5	2
Coal Mining	96	126	131.3	1.75
Manufacturing	177	309	174.5	3.25
Steam Railroads	85	132	155.3	2.5
Electric Light + Power	72	192	268.1	6

Using 3%, we have.

$$g = \frac{g_L + \mu\left(1 - \left[\frac{1}{1.03}\right]^7\right)}{\frac{1}{1.03}} = \frac{g_L + \mu\left[1 - \frac{1}{1.23}\right]}{\frac{1}{1.03}}$$

$$g = 1.03\left[g_L + \mu(.81)\right] = 1.03\left[g_L + \mu .19\right]$$

assume $\mu = 4\%$ $\mu(.19) = .0072$

Decade ending	g_L	g est	g actual.
89	3	3.8	4
99	2 1/4	3.06	3 1/2
1909	2 1/4	3.06	4
19	1 1/2	2.29	2 1/4
29	1 1/4	2.04	2 1/2
39	1 1/8	1.80	2

An estimated 3% per annum increase in labor efficiency during this interval makes the computed growth ~~of the~~ fairly comparable to the actual growth — a result which is quite amazing when the constant 3% increase in labor efficiency is used for the entire period 1899-1939.

The greater actual growth in income as compared with the estimated growth can be attributed during part of this period to the capital deepening that was going on.

S-1

The rather cursory analysis of the statistical information indicates 1) that the concepts developed in the paper are useable for the analysis of data.

2) much more careful analysis is necessary before a thoroughgoing statistical analysis of growth can be made